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ABSTRACT

This document notes that researchers study the processes involved in judgment and decision making and prescribe theories and models that reflect the behavior of the decision makers. It addresses the various models that are used to represent judgment and decision making, with particular interest in models that more accurately represent human behavior. Two types of models of judgment and decision making are discussed: those that focus on the development and application of normative decision rules based on formal, logical analyses derived from economic or statistical considerations; and those that focus on how people actually go about making judgments and decisions. While the first type of model examined assumes that humans are rational decision makers, the second type of model emphasizes the interaction of the processes involved in judgment and decision making. Models of judgment and decision making are reviewed with emphasis on the methods used to study them. Descriptive models are described with specific reference to think-aloud protocol, regression analysis, and heuristic strategies. The paper provides the rationale for each model and evaluates the method based on the particular model. It concludes that methods such as information integration, policy capturing, and heuristics remain useful in the investigation of judgment and decision making, but that other methods such as the multiple cue probability learning method and the dynamic decision making method may not be applicable. (NB)

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Human judgment and decision making: Models and applications

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ABSTRACT

Researchers study the processes involved in judgment and decision-making and prescribe theories and models that reflect the behaviour of the decision makers. The present study provides an overview of the development of models derived from theories and illustrates the development of the methods and models for understanding the processes underlying judgment and decision-making. The two general prescriptions for consistent behaviour--normative (static and dynamic) and descriptive--are the focus of judgment and decision-making researchers. Models of judgment and decision making are reviewed with emphasis on the methods used to study them. While dynamic models represent real judgments better than static models, both models are inadequate. Descriptive models are described with specific reference to think-aloud protocol, regression analysis, and heuristic strategies. The present paper provides the rationale for each model and evaluates the method based on the particular model. In general, the current methods remain useful in studying judgment and decision-making and an understanding of the judgment and decision-making processes will lead to the development of better decision aids.

Human judgment and decision making is one of the areas of contemporary interest in psychology. Decisions to get married, have children, go to graduate school, change career, and buy a house have great impact on one's life. Political decisions by voters and governments may change the development of the nation. Therefore, behavioural researchers have examined the process of judgment and decision. The assumption is that judgments and decisions can be studied by empirical methods from psychological research. A simple behaviour such as guessing the likelihood of a "head" in a toss of a coin could be predicted by the law of probability. More complex behaviour such as the purchase of a house, choice of a mate, or selection of a graduate school would only require the development of new models to account for the behaviour (e.g., Brunswik's lens model [Brunswik, 1952 & 1956] and information integration theory [Anderson, 1974 & 1981]).

The present paper addresses the various models that are used to represent judgment and decision making. Of particular interests are models that more accurately represent human behaviour. Two types of models of judgment and decision making are discussed. The first focuses on the development and application of normative decision rules based on formal, logical analyses derived from economic or statistical considerations. Such a model assumes that humans are rational decision makers. The second focuses on how people actually go about making judgments and decisions. Such a model emphasizes the interaction of the processes involved in judgment and decision making.

DEVELOPMENT OF JUDGMENT AND DECISION MODELS

Normative models

Prior to the 1960s, normative models were emphasized in the study of judgment and decision making. The model assumed that humans act in a Bayesian manner, that is, they behaved with respect to a combination of formal probability and utility. For example, what is the probability of obtaining 8 blue and 4 white pokerchips on 12 successive independent draws from a bag of 70 blue and 30 white pokerchips? If individuals employed the appropriate laws of probability, then their behaviour would conform to that predicted by the mathematical formula (Bayes' theorem). To examine such a case, the actual behaviour of the individuals are compared with rational behaviour predicted by the law of probability. Such an analysis that compares actual behaviour to rational behaviour is a normative one. The analysis prescribes behaviour that conforms to the law of probability and in this instance, the analysis predicts an occurrence (behaviour) by multiplying the prior odds by the likelihood that the event could have occurred.

One of the earliest normative models was the utility model. According to the utility model, the individuals in a choice situation would choose the alternative with the highest expected utility. Suppose individuals choose Coke over Pepsi in the choice set (Coke and Pepsi) and choose Pepsi over 7-Up in the choice set (Pepsi and 7-Up), then they should choose Coke over 7-Up in the choice set (Coke and 7-Up). The choice of Coke over Pepsi or 7-Up has the highest utility value, therefore Coke is chosen.

Static and dynamic models of utility. Within the period of normative models, two kinds of utility models were introduced: static (deterministic) and dynamic (stochastic) models. The expected utility (EU)

maximization model (von Neumann & Morgenstern, 1947) was one version of the static model. The model predicts that individuals will take the course of action with the largest sum of product of subjective value (utility) and objective probability of payoff. Around 1954 onwards, a shift from static to dynamic models occurred. Edwards (1954) argued that the objective probability considered in static models should be substituted with the subjective probability to account for risky (gambling) decision behaviour. Consequently, the subjective expected utility (SEU) model (Edwards, 1961) was introduced; the model states that the individuals choose the action with the largest sum of the product of subjective value (utility) and subjective probability of the payoff.

Subjective probability is defined as a probability of payoff determined by the individuals. One interpretation is that the number represents the extent to which an individual thinks a given event is likely (Savage, 1954). Individuals can choose any probability prior to the first occurrence of an event and change the probabilities on subsequent occurrences. In other words, the probability is estimated or guessed at the initial stages followed by subsequent estimates of probabilities as a result of experience.

Theoretical shift. The shift from static to dynamic models was brought about by the development of the subjective expected utility model. Dynamic models more accurately represent real judgments that involve a series of choices whereas static models can determine only the occurrence of a choice among courses of action. Also, dynamic models could account for preference events that are inconsistent and intransitive. In an inconsistent event, Event 1 is not always preferred to Event 2. In an intransitive event, given that Event 1 is preferred to Event 2 and Event 2 is preferred to

Event 3, the preference for Event 3 instead of Event 1 could occur. Furthermore, dynamic models could account for the variances of preferences, that is, when the variances of bets confound with the utility of the subjective expected utility model (Royden, Suppes, & Walsh, 1954).

Dynamic models make assertions about the probability between choices. One of these is Luce's (1959) Choice Axiom. This axiom states that the ratio of the probability of choosing alternative A to the probability of choosing alternative B is a constant, independent of the number of alternatives in the set of choices. For example, if A is preferred 2:1 over B when only A and B are in the choice set, then the 2:1 ratio should be maintained even if C and D are introduced as alternative choices. Say that C and D are each chosen 20 percent of the time. Then, according to Luce's Choice Axiom, A should be chosen 40 percent of the time and B 20 percent of the time. Mathematically stated, the probability of choosing C, given that C is a subset of B and B is a subset of A, is the sum of product of probabilities of C X B and B X A.

Evaluation. Researchers developed static models to predict future judgments and decisions. The models, however, failed to accurately predict behaviour; perhaps these theories and models were developed with the support of contrived (laboratory) data or are developed with an exactness that does not allow accurate prediction given slight variations in real judgment and decision making situations. As a consequence, dynamic models are preferred because they correspond more closely to real judgment and decision making situations. One suggestion is that researchers start with the development of dynamic models to describe the multi-variables that influence behaviour and whenever possible, work towards the development of static models that have greater predictive power.

Both static and dynamic models assume that individuals attempt to

perform in a particular way that will maximize performance based on utility and probability. For example, in a bargaining situation, individuals tend towards equal distribution of payoffs. This split-the difference principle (Flood, 1954 & 1955) is observed in a three-person game where two individuals tend to seek equity by bargaining in a way as to disadvantage a third stooge player (Hoffman, Festinger, & Lawrence, 1954). However, not all bargaining games observed the split-the-difference principle. Scodel, Minas, Ratoosh, and Lipetz (1959) examined a non-zero-sum non-co-operative game called the Prisoner's Dilemma (see Luce & Raiffa, 1957) where each player seeks to obtain the optimal stategy even though the payoffs are little. Edward (1961) concluded that free communication encourages equity and restricted communication encourages optimal stategies regardless of the importance of payoffs. Thus, both static and dynamic models that considered utility and probability to predict decisions are not sufficiently adequate.

Descriptive models

By the 1970's, the emphasis in behavioural decision theory had changed from normative to descriptive models. Descriptive models assumed that humans do not act in a Bayesian manner. As in the bookbag-and-pockerchips example (discussed in an earlier section), the typical judgment is 0.75 whereas the actual mean probability value is 0.97. Thus, such a response is a large error of underestimation of the response predicted by law of probability. Such an error has been labeled "conservatism" (Phillips & Edwards, 1966), and the finding illustrates that judgment and decision making are not according to the predicted laws of probability. Therefore, as an alternative, a descriptive analysis of behaviour is considered whereby the analysis does not determine whether judgments and decisions are

rationally optimal, but rather merely describes the underlying processes involved in judgment and decision making. In other words, descriptive analysis describes the individuals' behaviours and incorporates them into the analysis.

Studies of conservatism--the tendency to combine probabilistic information to come up with a posterior probability closer to the prior probability than specified by Bayes' theorem (as in the bookbag-and-pokerchips illustration)--and cascaded inference studies--the use of information at each stage to obtain inferences even when the information is unreliable (as in the reliance of doctors on a thump on the patient's chest)--showed that the normative model which views the individuals as good intuitive statisticians is inaccurate. Several features of the bookbags-and-pokerchips task could be examined in a descriptive manner. For example, while Bayes' theorem does not consider the order in which blue and white chips are sampled, a human judge may well be influenced by this factor. When order was examined, Shanteau (1972) found a strong recency effect where the judgment on a given trial depended most heavily on the immediately preceding outcome.

Furthermore, individuals also use rules-of-thumb strategies (heuristics) to reach decisions which are not considered in normative models. To illustrate, when Americans are told that "Steve is a meek tidy man" and are then asked to select the most likely profession of Steve from a list of occupations--farmer, salesman, airline pilot, librarian, and physician--most of them chose "librarian" instead of "farmer." They, however, ignored the statistics (base rate) that the United States has more farmers than librarians (Kahneman & Tversky, 1973; Tversky & Kahneman, 1974). Individuals evaluated the degree to which Steve's profession is similar in essential properties to its parent population (i.e., similarity between

events or representativeness rather than the frequency or base rate [Kahneman & Tversky, 1972]).

Methods. The focus on descriptive models results in the development of new methods which examine the process involved in judgment and decision making. For example, to study the multiple attributes that influence interpersonal and intergroup conflicts, computer programs have been designed to accept decisional variables of the individuals and their relative importance and generate outcomes of the conflicts (Hammond, 1971; Hammond, Stewart, Alderman, & Wascoe, 1975). Participants judged the weights (importance) of each variable, as in the study on public participation in regional impacts of alternative land use policies (Hammond, Stewart, Brehmer, & Steinmann, 1975), that examined aspects of recreation, agriculture, industry, and environment. Policy makers, then, would be in a position to examine the different viewpoints of the factions within the community by examining the interaction and weights of the variables of each faction.

Specific programs can follow an individual's progress and provide continuous recommendations on the next decision (Paris, Weisbrod, Freedy, & Weltman, 1975). Individuals could seek information from an information-display board and the sequence in which information is sought can be recorded (Payne, 1976) or individuals' eye-movement conjointly with verbal protocols are recorded (Russo & Rosen, 1975) to track the information processing sequence.

To further describe the roles of relevant factors that lead to judgments and decisions, designs in which each of several factors is manipulated across several levels and all possible factor level combinations are constructed. For example, if Factor A has three levels

and Factor B has two levels, then the complete factorial design contains six different combinations. Analysis of variance tests can be used to determine the relative importance of each factor on the judgment of interest.

GENERAL METHODOLOGY

Think-aloud protocol. Descriptive models focus on the examination of the process involved in judgment and decision making. One early method of identifying the psychological process is the think-a-loud protocol (Newell & Simon, 1972). Individuals describe their mental actions while they perform a task (think-aloud) and their responses are recorded. The responses are charted in terms of a decision tree diagram--a representation that shows the stages of the responses across time.

Regression analyses. Subsequent methods assume that the judgmental process is an algebraic one; individual factors are identified, weighted, and combined to result in decisions. The process of combining the weights is done via regression techniques such as analysis of variance, conjoint measurement, and multiple regression. Specifically, analysis of variance focuses on interaction of variables, conjoint measurement examines the scaling techniques for rank-ordered data (with the assumptions that humans can rank better than provide a number in scaling), and multiple regression investigates the linear combination of variables. Other regression techniques such as information integration (Anderson, 1974) examines the type of combination rule of variables (e.g., adding or averaging rule), policy capturing (Hammond, Stewart, Brehmer, & Steinmann, 1975) examines the relations of environmental cues and the judgment of the decision makers (e.g., alternative land use policies), multiple cues probability learning (Slovic & Lichtenstein, 1977) examines the cue interrelationships, and

dynamic decision making (Rapport, 1975; Rapport & Burkhiemer, 1971) examines the information available for later decisions based on outcomes of earlier decisions.

Heuristics and strategies. Another assumption of judgement and decision making is that the capability of the information processing system is limited. Individuals experience limited cognitive capacity and therefore, they resort to rules-of-thumb devices or heuristics (Kahneman & Tversky, 1972 & 1973) and cognitive shortcuts (e.g., cognitive scripts [Abelson, 1976]).

Tversky and Kahneman (1972) showed that individuals rely on a few heuristics principles to reduce the complex task in judgment and decision making into simpler operations. The three basic types of heuristics are: (a) representativeness, (b) availability, and (c) anchoring and adjustments. Representativeness is the principle whereby individuals connect an event A with event B by assessing the degree of similarity between them, that is, how much one event "represents" the other (Kahneman & Tversky, 1972). For example, if a child has blue eyes and the parents have blue eyes, the probability that the child is theirs is high. Thus, the child is highly representative of the parents who have blue eyes. Availability is the principle where the relative frequencies of events are estimated by how easily specific examples of the event are retrieved from or available in memory (Tversky & Kahneman, 1973). For example, if individuals are asked to judge the rate of marriages, they would do so based on the availability of related experiences or known marriages. If in the past few months these individuals have heard of or had friends who went through such experiences, they would predict the rate to be high. Lastly, adjustment and anchoring is the principle where individuals make decisions by starting from an initial value that is adjusted in order to produce the most accurate

prediction.

RECENT CONSIDERATIONS

In making a decision, individuals are generally concerned with how to represent the problem and subsequently, how to use one's mental capabilities (attentive, perceptual, learning, memory, and cognitive skills) to influence the process of judgment and decision. To examine the influence of the capabilities on judgment and decision making, limited information processing models are considered. The assumption is that judgment is decomposed into several sub-processes, and due to the limitations of the immediate memory limited information can be processed at a time. For example, Einhorn and Hogbarth (1981) represented judgment as the acquisition and evaluation of the incoming information, the action, and consequences (learning/feedback) to produce an outcome (see upper panel of Table 1). Another model (Pitz & Sachs, 1984) considers the interaction of psychological, cognitive, and affective variables on information to produce an outcome (see lower panel of Table 1).

INSERT TABLE 1 ABOUT HERE

Another view is that the judgmental process is a developmental one similar to Kohlberg's (1979) moral stages of development. Judgment is considered as an organization of thought processes at a particular stage of development. Therefore, decisional biases or errors are accounted for in terms of the unavailability or inaccessibility of a judgment and decision making technique at a particular stage. Furthermore, complex decisions may then require access to techniques located in organizations across different stages.

As to the use of heuristics, these techniques could be regarded as automatic cognitive skills that minimize effort on the part of the decision maker. Perhaps heuristics, like cognitive skills, are learned skills acquired through considerable training but once learned the skill is performed automatically and is difficult to modify. If so, whether heuristics are developed with little or no practice is of interest. Of note is that some cognitive processes such as frequency monitoring do not need practice to be automatic (Hasher & Zacks, 1979).

CONCLUSION

In general, methods such as information integration, policy capturing, heuristics, and strategies remain useful in the investigation of judgment and decision making. Other methods, however, may not be applicable. For example, studies showed that individuals fail to consider cue intercorrelations (Slovic & Lichtenstein, 1971) and have trouble applying the information even when they know the rules (Brehmer, 1973; Brehmer & Quarnstrom, 1976). Hence, the multiple cue probability learning method is seldom considered an appropriate descriptor of the judgment and decision process. Similarly, the mathematical complexity and numerous assumptions make the dynamic decision making method a seldom used one. Financial limitations (e.g., high costs of operation) and high task-specificity can limit the use of certain methods.

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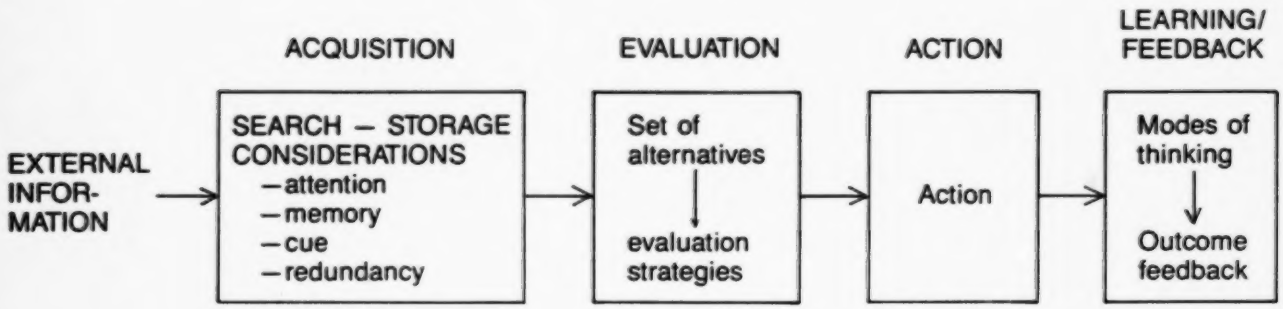
TABLE 1

INFORMATION PROCESSING MODELS

Limited version (Einhorn & Hogbarth, 1981)



Interaction version (Pitz & Sachs, 1984)